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(71) Applicant: INFORMHOTEL, S.A.
Princesa 40
Madrid 8(ES)

(72) Inventor: Frades Larumbe, Jesus Maria
Ronda de Cala Basa
13 Madrid-33(ES)

(74) Representative: Meddle, Alan Leonard et al,
FORRESTER & BOEHMERT Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) A miniature vehicle, a track for the vehicle and apparatus for controlling the motion of the vehicle along the track.

(57) Apparatus for controlling the motion of miniature vehicles along a track comprises power supply means including an oscillator (B1) and a frequency divider (B2) for supplying a signal comprising a plurality of different frequency component signals via spaced conductive strips on the track to the miniature vehicles. Each miniature vehicle carries two band pass filters each arranged to allow only one of the different frequency component signals to be supplied to respective switching means (T1, T2) controlling operation of a corresponding drive motor (M1, M2) arranged to drive a respective one of two drive wheels of the vehicle to control the motion of the vehicle on the track.

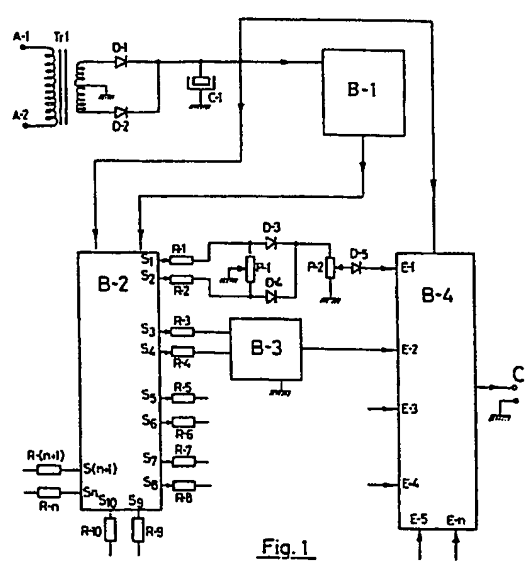

Fig. 1

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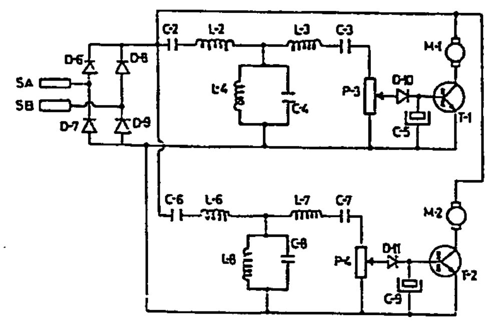
Fig. 3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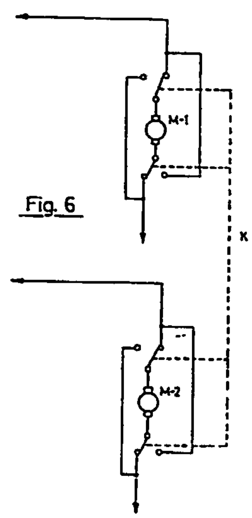
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Fig. 6

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"A miniature vehicle, a track for the vehicle and apparatus for controlling the motion of the vehicle along the track"

THIS INVENTION relates to the control of miniature vehicles, such as cars, adapted to travel along a track and to the construction of the miniature vehicles and track.

In one known apparatus for controlling the motion of miniature cars on a track, rails formed with grooves are provided on the track and the cars are secured via the grooves to the rails which supply driving power to the cars and guide the motion of the cars which do not have steering systems. In such an apparatus the maximum number of cars which can be positioned simultaneously on the track is equal to the number of rails provided, there being no point in providing more than one car per rail, since the cars will collide because there is no possibility of independently controlling more than one car on a single rail.

In another known apparatus two or more sets of rails are provided onthe track and each rail has three conductors. Unlike the first described known apparatus, each car is not secured to the respective rail, via a groove fromed therein, but merely takes power from the rail. In such apparatus, the cars can change rails in a two-step operation. However, the number of rails is limited because each car takes energy from two out of the three conductors on each rail via an arrangement of brushes. All the cars present must take energy from a common conductor and a different conductor as defined by the position of the brushes. The number of brushes which can be provided in the car assemblies is limited by the size of the car. Such apparatus makes continuous steering impossible, and the number of cars which can be simultaneously positioned on the track is limited by the width of the track and the number of possible current taps. In practice, only two

cars can be simultaneously positioned on the track.

In yet another known apparatus for controlling the motion of miniature cars each car is provided with a power source and a radio receiver, and the steering and speed of the car is controlled by a radio transmitter. The apparatus has the advantage of not requiring a track but has the disadvantage of very high weight, volume and cost.

According to one aspect of the invention, there is provided apparatus for controlling the motion of miniature vehicles along a track having spaced electrically conductive strips each extending along the length of the track, comprising electrical power supply means for supplying a signal constituted by a plurality of different frequency components signals to respective drive means of each vehicle via the conductive strips on the track and filtering means carried by each vehicle for allowing only a given frequency component signal of the power supply signal to control the motion of that vehicle.

According to a second aspect of the invention, there is provided a miniature vehicle movable along a track having spaced electrically conductive strips each extending along the length of the track of, comprising means for supplying an electrical power supply signal constituted by a plurality of different frequency component signals from the conductive strips of the track to drive means of the vehicle and filtering means for allowing only a given frequency component signal of the power supply signal to control the motion of the vehicle.

According to a third aspect of the invention, there is provided a track for miniature vehicles, comprising a plurality of conductive strips each having the same width and extending along the length of the track, each pair of adjacent conductive strips being separated by an insulating strip of a width equal to or slightly less than the width of the conductive strip, the width of the conductive strips being arranged to be equal to or slightly less than the distance between a pair of electrically conducting brushes provided on each miniature vehicle to allow power to be supplied to the vehicle via the conductive strips of the track and the width of the insulating strips being arranged to be equal to or slightly greater than the width of the

brushes.

The main advantage of apparatus embodying the invention is that the number of miniature vehicles which can be simultaneously positioned on the track is unlimited. Further, the vehicles can be placed in lines behind one another or parallel to one another, in the same manner as in real race-tracks.

The steering and speed control of apparatus embodying the invention is gradual and progressive, irrespective of the number of vehicles and the position of each vehicle on the track. The cost of the apparatus is comparable with that of either of the first two known apparatuses described above and much lower than the cost of the third known apparatus.

Also the entire track is a source of energy, so that vehicles can travel along any part of the track and any number of vehicles up to a maximum number can be positioned on the track each vehicle receiving its own signal and the direction and speed of each vehicle being controlled independently of the other vehicles.

Preferably, means are provided to enable the direction of motion of a vehicle to be reversed such that the vehicles can move either forwards or backwards in either of two opposite directions along the track.

In order that the invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which

FIGURE 1 is a circuit diagram of the power supply circuit of apparatus embodying the invention;

FIGURE 2 illustrates diagrammatically the underside of part of the track of apparatus embodying the invention;

FIGURE 3 is a circuit diagram of signal filtering and motor actuating arrangement provided in each car;

FIGURES 4 and 5 are circuit diagrams illustrating alternative motor actuating arrangements;

FIGURE 6 is a circuit diagram of a switching system provided in a car to enable the direction of motion of the car to be reversed; and

FIGURES 7 and 8 are circuit diagrams illustrating modifications made to the signal filtering and control respectively of apparatus embodying the invention to provide an alternative arrangement to that shown in Figure 6 for enabling the direction of motion of a car to be reversed.

Referring now to the drawings, Figure 1 is a circuit diagram of the power supply and control circuit of apparatus embodying the invention.

The power supply and control circuit comprises a conventional transformer Trl having a primary winding connectable via terminals A1 and A2 to a power supply. The transformer Trl may be adapted to be suitable for use with any of the conventional supply voltages used in various countries that is with any supply voltage from 110 to 240V AC at frequencies of 50 to 60 Hz. The secondary winding provides the operating voltage for the apparatus which is insulated in the manner required by law for toys.

The second winding of the transformer Trl has an earthed central top and the terminals of the windings are connected to diodes Dl and D2 to provide full wave rectification of the transformer output. Alternatively a bridge rectifier arrangement or any other known rectifier arrangement which may be preferred for economic reasons may be used. An earthed filtering capacitor is connected to the output from the rectifying circuit to remove any remaining AC components to ensure that the DC output signal has a low ripple factor.

The output from the full wave rectifying circuit is input to an oscillator Bl which is a conventional electronic high frequency oscillator of good stability, for example a quartz crystal oscillator or a DC oscillator, which is less expensive, may be used. In practice, the output frequency of the oscillator should be at least 2MHz.

The output from the full wave rectifying circuit is also input as is the output of the oscillator B1 to a frequency divider B2 which may be of any conventional type, although it is preferable and more economic to use a commercial integrated circuit having an input adapted to receive a signal at any frequency such that as long as a signal is present at the input of the frequency divider a large number of output signals having frequencies which are sub-multiples of the input frequency are output from the frequency divider.

Each pair of outputs $(S_1-S_2)....(S_n-S_{n+1})$ provides the signals for controlling a car. The signals are continuously processed so that the car moves in accordance to a proportioned mixture of the two signals produced in the corresponding control.

Each output signal from the frequency divider B2 comprises a DC signal pulsating at a fixed frequency determined by a high-amplitude fundamental AC component which is characteristic of that particular output signal. The AC component of the output signal is used to transmit an order to the associated car, which as will be seen hereinafter is provided with a band-pass filter which transmits only the AC signal of the particular frequency assigned to that car. Signals having a fixed frequency and polarity of the aforementioned kind are easy to obtain with frequency dividers using integrated logic circuitry.

Each of a pair of output signals is connected via a respective resistor to a control unit B3. Thus, output signals S_3 and S_4 are connected via respective resistors R_3 and R_4 to the control unit B3.

The control unit B3 associated with the pair of signals S_1 and S_2 is shown in detail in Figure 1. Thus resistors R_1 and R_2 respectively connect the output signals S_1 and S_2 to the control unit B3.

The control unit B3 comprises a potentiometer P1 having an earthed slider connected across the output signal lines S_1 and S_2 from the frequency divider B2. The terminals of the potentiometer P1 are each connected to the anode of a respective diode D3 or D4, the cathodes of which are connected in common to one terminal of a potentiometer P2. The other

terminal of the potentiometer P2 is earthed, while the slide thereof is connected to the anode of a siode D5, the cathode of which is connected to input E1 of a common DC amplifier B4. Diodes D3, D4 and D5 serve as isolating components.

The potentiometer P1 has an earthed shield, such that when the slider is moved toward the terminal of the potentiometer connected to the output signal S_1 that is a top position, signal S_2 is attenuated whereas when the slider is moved toward the other terminal of the potentiometer, that is a bottom position, signal S_2 is attenuated.

Thus, when the slider of potentiometer P1 is in a central position, the signal arriving at potentiometer P2 comprises two components of the same amplitude, whereas when the slider is in the top position the signal input to potentiometer P2 comprises the signal S_2 only.

A proportion of the signal at P2 is input to the input E2 of the common amplifier B4, the proportion depending upon the position of the slider of potentiometer P2. Diodes D3, D4 and D5 prevent the signals at the cathodes thereof influencing the signals at the anodes and provide output signals of a fixed polarity, which is positive in the present case.

Each pair of signals (S_1-S_2)—(S_n-S_{n+1}) is associated with a respective control unit similar to that described above. The number of control units used of course depends on the number of cars used. The common DC amplifier B4 should be suitable for amplifying all the different frequencies produced by the frequency divider and thus should have a band width equal to the frequency range used. The amplifier amplifies the signals to the required level and uses the signals providing a single output connection C to the track. The amplifier may be of any commercial type, including a commercial integrated circuit. The essential feature is that the amplifying device contains only one amplifier to which all the output signals from the various control units B3 are input and which supplies a single output signal after mixing and amplification of the output signal.

Further it should be noted that all the components on the control circuit preferably have very low thermal dissipation.

Of the two control potentiometers described above, P1 is provided to allow the associated car to be steered and P2 to control the speed thereof. Potentiometer P1 varies the relative amplitudes of the two input signal frequencies as described above and P2 varies the amplitude of the resulting output signal.

The two potentiometers P1 and P2, which process low-amplitude signals, are contained in a case or structural unit called a "control box" which is connected when required to actuate the associated car to the appropriate connections of the frequency divider B2 and the amplifier B4 for that car, since that particular car will only respond to that pair of frequencies which is assigned to it during manufacture.

As mentioned above, connection to the track is made via a single connection C comprising an outut signals line and an earthed line. The track comprises a base made of electrically insulating material which is preferably a plastics material and which prevents excessive skidding of the cars or other miniature vehicles used. The material used and the shape of the track can be of any kind suitable for the present purpose.

Normally the track will be made up of straight and/or curved sections so as to produce various routes having various dimensions as required by the user. The sections of track may be connected in a conventional manner which ensures electrical continuity between the conductive parts of one section of track and the corresponding parts of another.

The track is made up of various strips of conductive material insulated from the immediately adjacent strips and connected together or to the amplifier and has a smooth surface that is the strip of insulating material between each pair of conductive strip is at the same level as the conductive strips. The asembly formed by the conductive and insulating strips occupies the entire width of the track.

Each car comprises a pair of brushes made of a suitable conductive material and of any shape and dimension, (the brushes being) any appropriate distance apart. Each brush can have any width, since the width does not affect the operation of the apparatus.

Thus if v is the distance separating a pair of brushes and a the width of a brush, then for effective operation of the apparatus, the width of each conductive strip should be equal to v, and the width of the insulating strip should be a.

If the width of the conductive strip were greater than v, the car or cars would come to a stop on the track, since both of a pair of brushes could contact a single conductive strip forming a short-circuit and preventing power reaching the car, whereas if the width were less than v the apparatus would not operate optimally. Further, if the width of the insulating strip were less than a a brush may short-circuit two consecutive conductive strips, which would cut off the power supply signals to all the cars, not only the car causing the short-circuit, since the amplifier outut signal would have been short-circuited, while if the width of the insulating strip were greater than a the apparatus would not operate optimally.

There may be any number of conductive strips, depending on the width of the track, the distance between brushes and the width of the brushes.

As shown in Figure 2, the conductive strips in each section of track are electrically connected at a single place underneath the track. A conductive strip A nearest one side of the track is connected to the next but one conductive strip B and every alternative conductive strip thereafter (not shown). Similarly, the conductive strip D adjacent the strip A is connected to the next but one strip E and to every alternate conductive strip thereafter (not shown).

Conductive strips D and all the conductive strips connected thereto are connected via connection C to the positive output terminal of the amplifier B4 while inductive strip A and the strips connected thereto are conected to earth.

Adjacent sections of track are joined in the obvious manner, that is by connecting a conductive strip in one section to the corresponding strip in the next section. Only one section of course is connected to the power source.

As a result of the construction of the track an electric signal which is a mixture of the output voltages from the frequency divider, after they have been suitably processed and amplified, appears across consecutive strips. Of course only the frequencies of the frequency divider connected to the control units B3 connected in circuit, that is the frequencies which are in use, will be present in the signal appearing across consecutive conductive strips, because where the control circuit is not connected to the amplifier the amplifier output will of course be zero for that pair of corresponding frequencies.

Referring now to Figure 3, there is shown a circuit diagram of a signal filtering and motor actuating circuit incorporated in each car.

As shown in Figure 3, brushes SA and SB provided on each car to make contact with the conductive strips of the track are connected to the anodes of diodes D6 and D8 respectively and to the cathodes of diodes D7 and D9 respectively, the cathodes of diodes D6 and D8 and the anodes of diodes D7 and D9 being respectively connected in common such that, when the brushes SA and SB are contacting respective conductive strips on the track, the brushes SA and SB form the bridge of a bridge rectifier circuit made up from diodes D6, D7, D8 and D9.

The common outputs of diodes D6 and D8 and diodes D7 and D9 are connected to two signal filtering circuits in the form of band pass filters, each band pass filter being arranged to allow only one of the frequencies emitted by the frequency divider to pass. The outputs from the filtering circuits are connected to respective motor actuating circuits to actuate the associated motor M1 or M2 which drives a respective one of the two driving wheels of the car. As usual, the driving wheels may be either the two front or the two back wheels of the car.

Referring now in detail to Figure 3, the common output of diodes D6 and D7 is connected to a capacitor C2 of one band pass filter and to one terminal of the associated motor M1. The common output of diodes D6 and D7 is also connected to a capacitor C6 of the other band pass filter and via the one terminal of the motor M1 to the corresponding terminal of the other motor M2. As can be seen from Figure 3, the construction of the two

filtering circuits is identical, although of course the values of the various components will vary depending on the actual band of frequencies desired to be passed by a particular filter.

The capacitor C2 is connected via inductancies L2 and L3 and capacitor C3 to one terminal of a potentiometer P3, the other terminal of the potentiometer P3 being connected via a connecting line to the common ouput of the diodes D7 and D9 of the bridge rectifying circuit. An inductance L4 and a capacitor C4 connected in a closed loop are also connected to the connecting line between the common output of diodes D7 and D9 and the other terminal of the potentiometer P3 and to a point between inductances L2 and L3.

The slider of potentiometer P3 is connected via the anode of a diode D10 to the base of an NPN transistor T1, which base is also connected to the connecting line from the common output of diodes D7 and D9 of the bridge rectifying circuit via a decoupling capacitor C5. The emitter of transistor T1 is directly connected to the common output of diodes D7 and D9, while the collector thereof is connected to the other terminal of the motor M1.

As can be seen from Figure 3, the signal filtering circuit connecting the output of the bridges rectifier circuit to the motor M2 is identical to that connected to the motor M1, although of course as a different frequency band pass is required for each band pass filter the values of the components differ. Thus, the capacitor C6 is connected via inductances L6 and L7 and a capacitor C7 to one terminal of a potentiometer P4, the other terminal of the potentiometer P4 being connected to the common output of diodes D7 and D9 of the rectifier circuit. A closed loop comprising an inductance L8 and a capacitor C8 is connected from the common output of diodes D7 and D9 to a point between inductances L6 and L7 in a manner identical to that described for the signal filtering circuit associated with the motor M1. The slider of potentiometer P4 is connected via a diode D11 and an NPN transistor T2 to the other terminal of the motor M2 and a decoupling capacitor C9 is provided in a manner identical to the signal filtering circuit of the motor M1.

Although not shown, the miniature cars have a shape and dimensions

suitable for their purpose and, as their purpose is to imitate cars travelling along main roads and race-tracks, the miniature cars will of course be small-scale reproductions of such cars. The cars of apparatus embodying the invention are arranged to behave in a manner identical to those cars on which they are modelled.

As described above, the driving wheels of the cars are actuated by electric motors M1 and M2, which motors are normally D.C. motors with excitation by a permanent magnet, the size and power of the magnet being proportional to the car, although any suitable motor may be used.

The two driving wheels of each car, that is the two front or the two back wheels, are driven independently by respective motors as shown above. Accordingly, as two motors rather than the normal one are provided, the power transmitted by each motor to the corresponding wheel need only be half of that required by the car. Consequently, each motor used is smaller in size than the single motor conventionally used to actuate both wheels.

By means of the brushes SA and SB, the car takes electric power from the conductive strips on the track, the power being just sufficient for the car to be driven and steered.

As the pulsed signals applied to the track are of only one polarity and the brushes on the car may take up any position on the track, the bridge rectifier is provided to ensure that all the signals on the track are applied with the same polarity to the car circuit.

Thus, because a certain number of conductive strips are disposed across the track, the brushes make contact with the strips such that sometimes the polarity of the car input signal is positive in one brush and negative in the other, whereas a few seconds later the polarity of the signal applied is reversed as the brushes may move across the conductors along any part of the track. Consequently, the rectifying bridge is arranged in the car so that the output therefrom always has the same polarity and consequently the car always moves in one direction, that is forward (although as will be seen hereinafter it is possible to arrange for the motion of the car to be reversed in a controlled manner).

The rectifier bridge, therefore, can always supply the motor terminals with a voltage having the required polarity, irrespective of the polarity applied to the brushes.

The signal reaching the car via the brushes appears at the inputs of the two band pass filters. Each filter transmits a single frequency component of the signal to the associated motor that is a portion of the signal having a frequency within the filter pass band, and rejects all others.

Although the fact is obvious, it is necessary to stress that the filters pass a band of frequencies near the cut-off frequency of the filter. Consequently the gap between the filter cut-off frequencies is made sufficient to avoid interference between adjacent frequencies in the signal supplied to the car, and the frequencies supplied by the amplifier are likewise sufficiently separated.

The filters are made up of active and/or passive components.

The outputs of the filters supply potentiometers P3 and P4 respectively and are rectified by diodes D10 and D11 and filtered by capacitors C5 and C9 respectively, causing transistors T1 and T2 respectively to conduct and consequently causing motors M1 and M2 respectively to be actuated, depending of course on the high-frequency signal transmitted by each of the associated filters.

As shown in Figure 3, the complete signals from the amplifier B4 having all frequencies present therein is applied to the terminals of the two assembled motors from the brushes via the rectifier bridge. A signal from the band-pass filter of the selected frequency appears at the base of the associated transistor T1 or T2 which acts as a switching means. The signal is proportional to the amplitude of the signal at the pass frequency of the filter. If the voltage of the signal at the pass frequency is zero, then filter output will be zero and the associated transistor will remain non-conducting preventing actuation of the corresponding motor.

Each transistor will conduct or transmit an amount of the signal dependent on the amplitude of the frequency component signal applied to

the base thereof. Consequently, the voltage at the motor terminals may be zero or the entire signal at any frequency present in the line. All intermediate voltage states at the motor terminals are possible, depending on the conductivity of the transistor.

The transistor may be replaced by relays. Thus as shown in Figure 4 a relay Rel havng a terminal actuated by the filter output signal, and a relay contact rel placed in series with the one terminal of the motor M1 is provided in place of the transistor. If a signal of a sufficient voltage appears at the filter output, the relay will cause the contact rel to close and the motor will receive all the applied voltage. If there is no signal or the signal is not of a sufficient voltage, the relay will not close the contact and the motor will not be actuated.

Figure 5 is a circuit diagram, showing an alternative motor actuating circuit wherein a thyristor Ts is used as a switching element to apply a voltage signal to the motor. In Figure 5, as before, the entire signal from the bridge rectifier is applied to the terminals of the assembly formed by the thyristor and the motor. The filter output voltage is applied to the thyristor gate. If the filter output voltage is sufficient to trigger the thyristor, the thyristor will conduct and consequently the motor will rotate at a speed proportional to the voltage of the signal in the track.

As can be seen, in the case where a relay or thyristor is used to supply a voltage to the motor, steering is efficient but abrupt, that is all or nothing. Thus, only if the voltage level at the filter pass frequency is sufficient will the relay be energized or the thyristor become conductive to activate the motor. If the voltage is less than required, the motor remains or is disconnected from the power supply.

If a number of cars are placed simultaneously on the track and the voltage aplied to a given motor is the resultant of all the voltages along the track, a reduction in the voltage of the signal controlling the given motor will not appreciably influence the speed of rotation of the car wheel driven by the motor until the voltage has dropped sufficiently for the transistor to stop conducting or the relay to be de-energized. At that instant the wheel speed will change from near the maximum to zero and the direction will

change abruptly.

However, if a transistor is used as the switching means, the effect is very different because in this application the transistor acts as a variable-resistance potentiometer, the resistance depending on the voltage signal applied to the base of the transistor. If the voltage signal applied to the base is zero the resistance of the transistor will be at a maximum whereas if the signal applied to the base is at a maximum the transistor resistance will be zero. Any intermediate value of the signal applied to the base results in a transistor resistance between zero and the maximum.

The voltage applied to the base of the transistor is the voltage at the associated filter output. The amplitude of the filter output voltage is directly proportional to the amplitude of the signal at the filter pass frequency. Consequently, irrespective of the voltage applied to the transistor assembly fromthe bridge rectifier, the voltage applied to the motor terminals is proportional to the control voltage supplied via the band pass filter, since the voltage drop at the transistor has a given value, for preferably all possible values between 0 and the maximum value, corresponding to the signals present in the track.

The control voltage signal reaching the motor of a given car is controlled by the control potentiometers P1 and P2 of the associated control unit B3.

When the slider of the steering potentiometer Pl is in the central position, corresponding to motion of the car in a straight line, the amplitudes of the control signal applied to the motors are equal. Consequently both motors and both driving wheels rotate at the same speed and the car moves in a straight line.

When the slider of the speed control potentiometer P2 is at a given position, the speed of each motor and thus each driving wheel depends on the position of the slider of the steering control potentiometer P3. If the position thereof is varied, one driving wheel rotates more slowly and the other rotates faster than the speed corresponding to the position of the slider of the speed control potentiometer P2. If the speeds of the slower

and the faster wheels are suitably adjusted, the direction of the car can be gently varied towards the right or left to allow the car to turn.

The operation of apparatus embodying the invention will now be described. The apparatus is connected to the mains voltage supply via terminals A1 and A2 of the transformer Tr1 which produces the required output voltage. Thus, AC voltage is then full-wave rectified by the full-wave rectifier comprising diodes D1 and D2 and is filtered by capacitor C1 to produce the required DC voltage signal having a low ripple factor under any operating conditions.

The D.C. voltage produced is supplied to the high-frequency oscillator B1, the frequency divider B2 and the amplifier B4.

The oscillator output signal is applied to the frequency divider B2 to produce the required number of different frequency output component signals.

If the power supply circuit is arranged such that the frequency divider output 14 signals at fourteen different frequencies, 7 cars can be placed simultaneously on the track and be steered by respective independent control units B3.

The control units for all the cars are identical and any car can thus be connected to any control unit.

However, not all the cars are identical, if only because all cars simultaneously placed on the track must be controlled by control signals of different frequencies. Clearly, two identical cars having filtering circuits passing the same frequency signal cannot be placed simultaneously on a given track, because both cars would receive the same control signals and would thus move at the same speed and change direction simultaneously and in the same manner. Of course, the outward appearances of the cars may be similar.

The positive terminal of the connection C from the amplifier is then connected to a positive connection terminal of the track and the earthed

terminal of the connection C is connected to the corresponding earth of the track.

A choice is then made of cars to be placed on the track. If frequencies f_1 and f_2 are chosen to control a first car and f_7 and f_8 are chosen to control the second car, the following connections are made.

One control unit B3 is connected to the output of the frequency divider B2 producing the pair of frequencies f_1 and f_2 while the other control unit B3 is connected to the outputs of the frequency divider B2 producing the pair of frequencies f_7 and f_8.

Since only two control units have been connected, the signal supplied to the track will be the mixture of signals of frequencies f_1, f_2, f_7 and f_8 only.

Each different frequency signal will have an amplitude dependent on the positions of the sliders of the steering and speed control potentiometers P1 and P2 for each car.

Of course, if _n_ cars are used and the corresponding control units connected in circuit, there will be 2_n_ different frequency signals. The amplitude of each different frequency signal will of course depend on the position of the sliders of the steering and speed control potentiometers of the associated control unit.

When the two cars in the example are placed on the track at any point thereof, the brushes provided in each car will touch two conductive strips simultaneously, one brush contacting a conductive strip having a positive voltage and the other contacting a conducting strip which is earthed or has a negative voltage to pick up the composite signal incorporating all the different frequency signals.

As described above, each of the two driving wheels of each car is associated with a motor which operates only if the correct frequency signal is present in the composite signal and the speed of the motor depends on the

amplitude of the signal passed thereto by the associated band pass filter.

One important feature is that the presence of a large number of cars simultaneously on the track does not result in significant attenuation of the voltage applied to each motor, since if more signals are present there is an increase in the mean value of the voltage driving the motor, compensating for the inevitable voltage drop at the power-supply amplifier B4.

When a car has been placed on the track, the brushes thereof make contact with the conductive strips such that the total voltage of the composite signal is applied across the one terminal of each motor and the switching element. In this case the composite signal is applied across the one terminal of the motor and the emitter of the transistor.

If the speed control potentiometer for the car is at its maximum-speed position and the steering control potentiometer is in the central position, the car will begin to move at full speed in a straight line, since both wheels are moving at the same speed, because the outputs of the filter corresponding to each motor is at the maximum and the associated transistor is at maximum conductivity having a very low resistance to the current travelling through the motor.

If the steering potentiometer is moved from the central position towards one extreme position, while retaining the speed control potentiometer in a given position, as explained above the voltage of one frequency signal f_1 at the output of the associated filter will decrease, causing a lower voltage signal to be applied to the associated transistor base. The transistor will accordingly be less conductive so that the voltage across the associated motor terminals will decrease, causing the motor and the corresponding wheel to rotate more slowly while the voltage of the other frequency signal f_2 will increase and cause the associated wheel to rotate more quickly, thus causing the rear to turn to the left or right as the case may be.

Although in the arrangement shown the voltage of a pair of different frequency signals are varied simultaneously by adjusting the position of the slider of potentiometers P1, independently adjustable steering controls could be provided.

If the slider of the steering control potentiometer is kept in a given position, for example the central position, and the slider of the speed control potentiometer is moved from the maximum speed position, the trajectory will be unchanged but the speed of the car will decrease since the output signals of both filters will have decreased in amplitude by the same amount. Consequently, the transistors associated with each of the two motors will have high resistance, reducing the voltage applied to the motors and consequently the speed of the car.

Of course, any car on the track controlled by frequencies different from those supplied by the control units will not move and if the slider of a speed control potentiometer is moved to the zero speed position the associated car will stop moving.

The direction of movement of a car may be reversed so that the car moves with the back end thereof foremost in one of two ways that is either by switching means provided in the car or by a control signal from the control unit.

The direction of motion may of course be varied by the steering control potentiometer independently of whether the car is moving forwards or backwards. Also, the direction of motion can be changed simply by placing the front of the car in the desired direction on the track.

Figure 6 illustrates a switching system provided in a car to allow the direction of motion of the car to be reversed. As shown, a manually operated four-pole two-way switch K is provided such that when the contacts are disposed as shown in Figure 6 in a "forward" position each motor receives voltage of the required polarity and the car moves forwards. However, in the other position of the switch K, that is the "reverse" position, the positive motor terminal is connected to the negative voltage supply and vice versa causing the motors and thus the associated driving wheels to rotate in the opposite direction and move the car backwards.

The above-described arrangement for reversing the direction of movement of a car is cheaper and adds less weight to the car, but is less efficient than the second arrangement to be described below.

Figures 7 and 8 illustrate the modification made to the signal filtering and motor actuating circuit and the control circuit respectively in order to provide a control signal to the car to cause the direction of movement thereof to be reversed.

Thus, a third different frequency signal is applied to each car via third band pass filter comprising components C10, L10, L11, C11, L12, C12. The third filter is identical in arrangement to the other two filters, although of course the values of the components are different, being selected to allow the frequency chosen for the third signal to pass. The filtered output is attenuated by a potentiometer P5, rectififed by a diode D12, smoothed by a capacitor C13 and input to a relay J which comprises four circuits each having two position and operates in identical manner to switch K of Figure 6. F_1 and F_2 are connections to the first filter and F_3 and F_4 to the second filter of the signal filtering and motor actuating circuit.

Figure 8 shows the modification made to the control circuit in order to allow the third frequency signal to be supplied to the associated cars.

A third frequency output of the frequency divider is connected via a resistor Ri, a two position manually operable switch I and a diode D13 to the appropriate input, in this case input E1, of the amplifier B4.

The third frequency signal is thus arranged to be an "all or nothing" signal and is either of constant amplitude when the switch I is closed and zero when the switch is open. When the third signal is of a constant amplitude, the relay J is actuated and the positions of the contacts are reversed, connecting positive and negative terminals of the motor to the negative and positive voltage supplies respectively and causing the motor to rotate in the opposite direction so as to move the car backwards.

The second arrangement for enabling the direction of motion of a car to be reversed is of course more complex and expensive. Technically this arrangement is very promising, but its application to commercial products will depend on commercial criteria.

As will be understood from the above description, in apparatus

embodying the invention each car can be moved independently of the others and is associated with its arm control frequency. Also, using one of the two described arrangements for reversing the direction of motion of a car allows some cars to be driven in one direction around the track while other cars are being driven in the opposite direction.

CLAIMS

1. Apparatus for controlling the motion of miniature vehicles along a track having spaced electrically conductive strips each extending along the length of the track, comprising electrical power supply means for supplying a signal constituted by a plurality of different frequency components signals to respective drive means of each vehicle via the conductive strips on the track and filtering means carried by each vehicle for allowing only a given frequency component signal of the power supply signal to control the motion of that vehicle.

2. Apparatus according to claim 1, wherein a further filtering means is carried by each vehicle for allowing a second given different frequency component signal also to control the motion of that vehicle.

3. Apparatus according to claim 2 wherein the drive means of each vehicle comprises two driving motors each controllable by a given one of the two frequency component signals associated with the car and each arranged to drive a respective drive wheel of the vehicle.

4. Apparatus according to claim 3, wherein the proportions of the two different frequency component signals associated with a given vehicle are variable such that the amplitudes of the two different frequency component signals may be simultaneously decreased or increased to control the speed of the given vehicle.

5. Apparatus according to claim 3 or 4 wherein the proportions of the two diferent frequency component signals associated with a given vehicle are variable such that the amplitude of one frequency component signal may be increased with respect ot the amplitude of the other in order to allow the associated vehicle to turn.

6. Apparatus according to claim 3, 4 or 5 wherein each driving motor of a vehicle is a DC electric motor and a full-wave rectifying means are carried by the vehicle to ensure that power is correctly supplied to the vehicle irrespective of the position thereof on the track.

7. Apparatus according to claim 6 wherein the supply of power to each DC electric motor of a car is controlled by respective switching means which in turn are controlled by a respective one of the two different frequency component signals associated with that particular vehicle.

8. Apparatus according to claim 6 or 7, wherein means are provided for reversing the connection of the power supply to a vehicle to allow the direction of motion of the vehicle to be reversed.

9. Apparatus according to claim 8, wherein the means for reversing the connection of the power supply to the vehicle comprise further switching means operable manually to reverse the connection of the power supply.

10. Apparatus according to claim 8, wherein an additional filtering means is carried by the vehicle to enable a third different frequency component of the power supply signal to actuate further switching means to reverse the connection of the power supply to the motors.

11. Apparatus according to any preceding claim, wherein the track is made up of a plurality of conductive strips each having the same width, the adjacent conductive strips being separated by respective insulating strips, arranged such that the conductive strips are of the same or greater width than the insulating strips and alternative conductive strips are connected in common to one teminal of the power supply means.

12. Apparatus according to claim 11, wherein each car is provided with two electrically conductive brushes contacting in use adjacent conductive strips of the track, the brushes being separated by a distance equal to or slightly greater than the width of a conductive strip.

13. A miniature vehicle movable along a track having spaced electrically conductive strips each extending along the length, of the track, comprising means for supplying an electrical power supply signal constituted by a plurality of different frequency component signals from the conductive strips of the track to drive means of the vehicle and filtering means for allowing only a given frequency component signal of the power supply signal to control the motion of the vehicle.

14. A miniature vehicle according to claim 13, wherein a further filtering means is carried by the vehicle to allow a second different frequency signal to control the drive means of the vehicle, each of the two different frequency signals being provided to control a respective one of two drive motors of the vehicle, each of which drives one of two drive wheels of the vehicle, the proportions of the two different frequency signals controlling the drive means being variable to allow the motion of the vehicle to be varied.

15. A track for miniature vehicles, comprising a plurality of conductive strips each having the same width and extending along the length of the track, each pair of adjacent conductive strips being separated by an insulating strip of a width equal to or slightly less than the width of the conductive strip, the width of the conductive strips being arranged to be equal to or slightly less than the distance between a pair of electrically conducting brush provided on each miniature vehicle to allow power to be supplied to the vehicle via the conductive strips of the track and the width of the insulating strips being arranged to be equal to or slightly greater than the width of the brushes.

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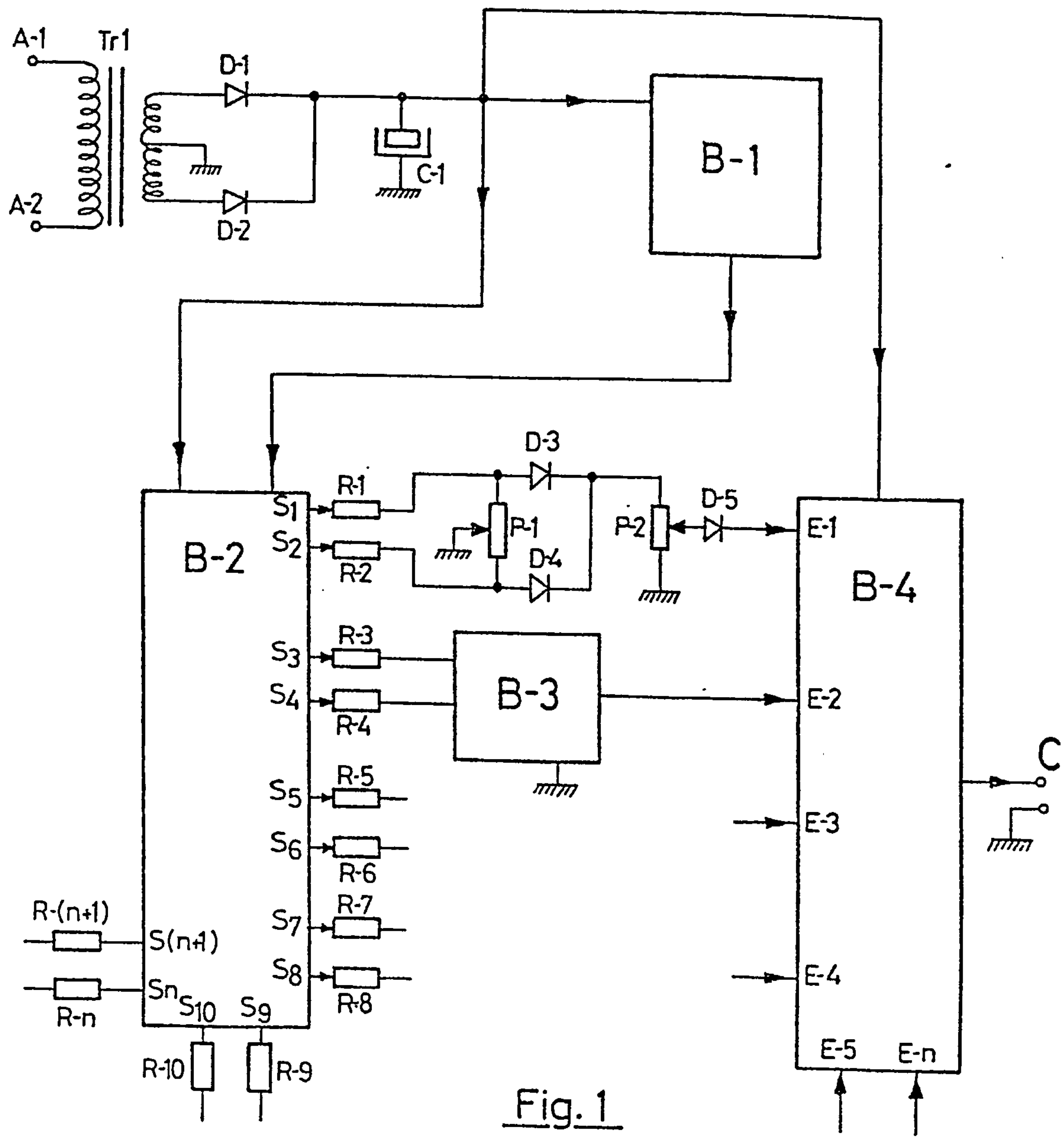

Fig. 1

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Fig. 2

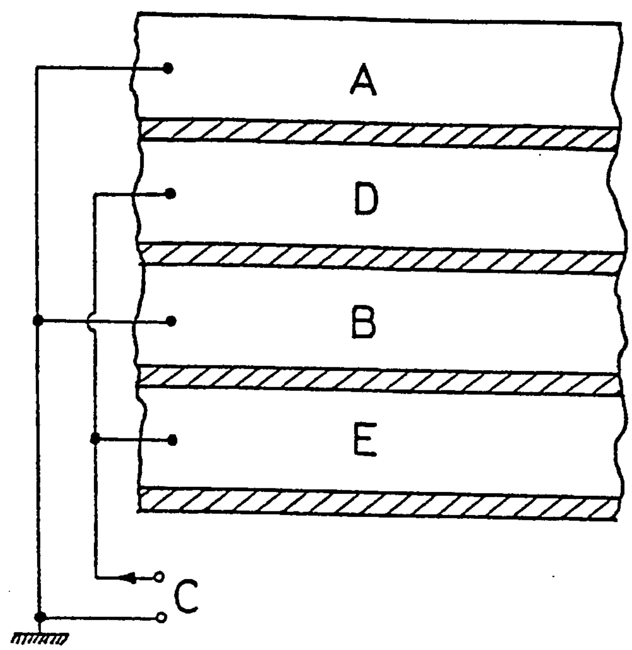

Fig. 3

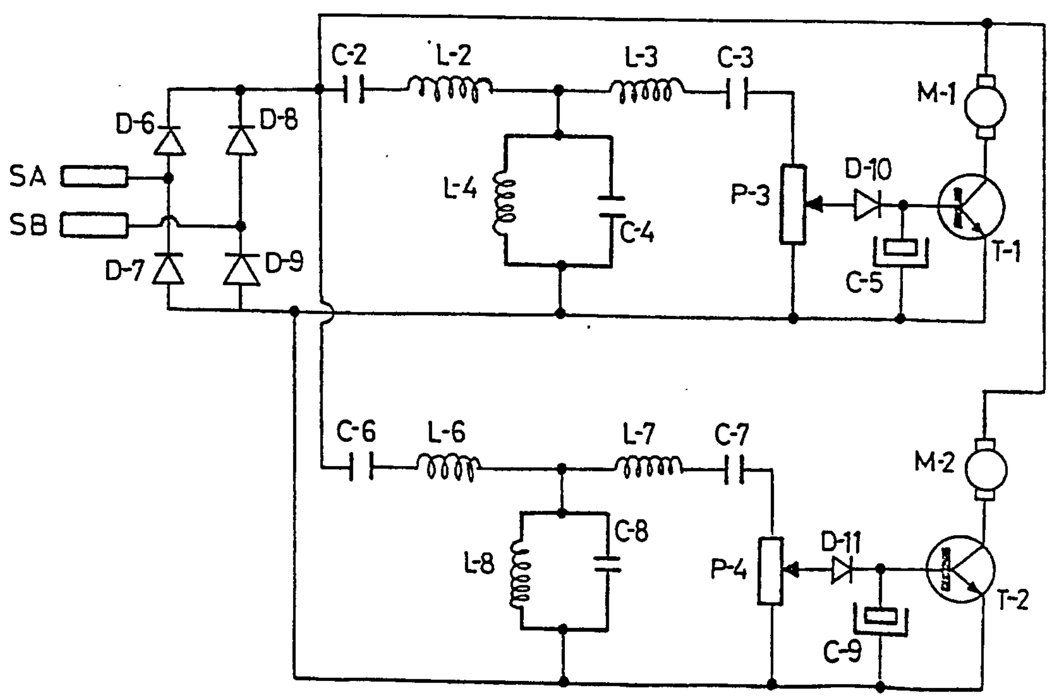

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Fig. 4

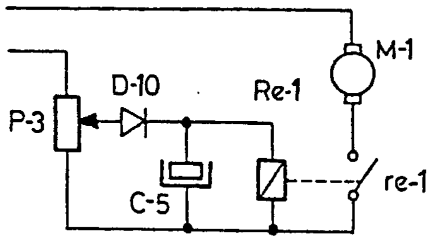
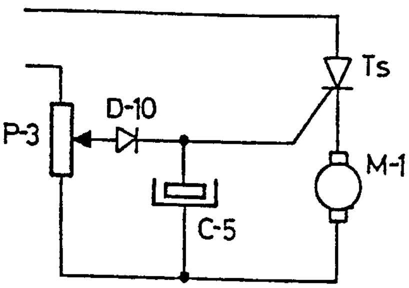


Fig. 5



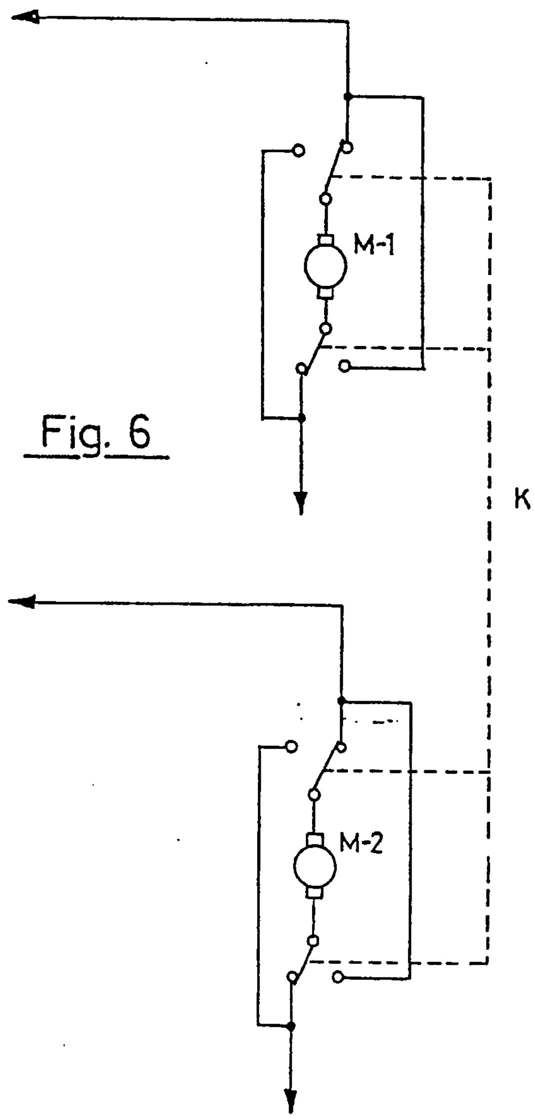


Fig. 6

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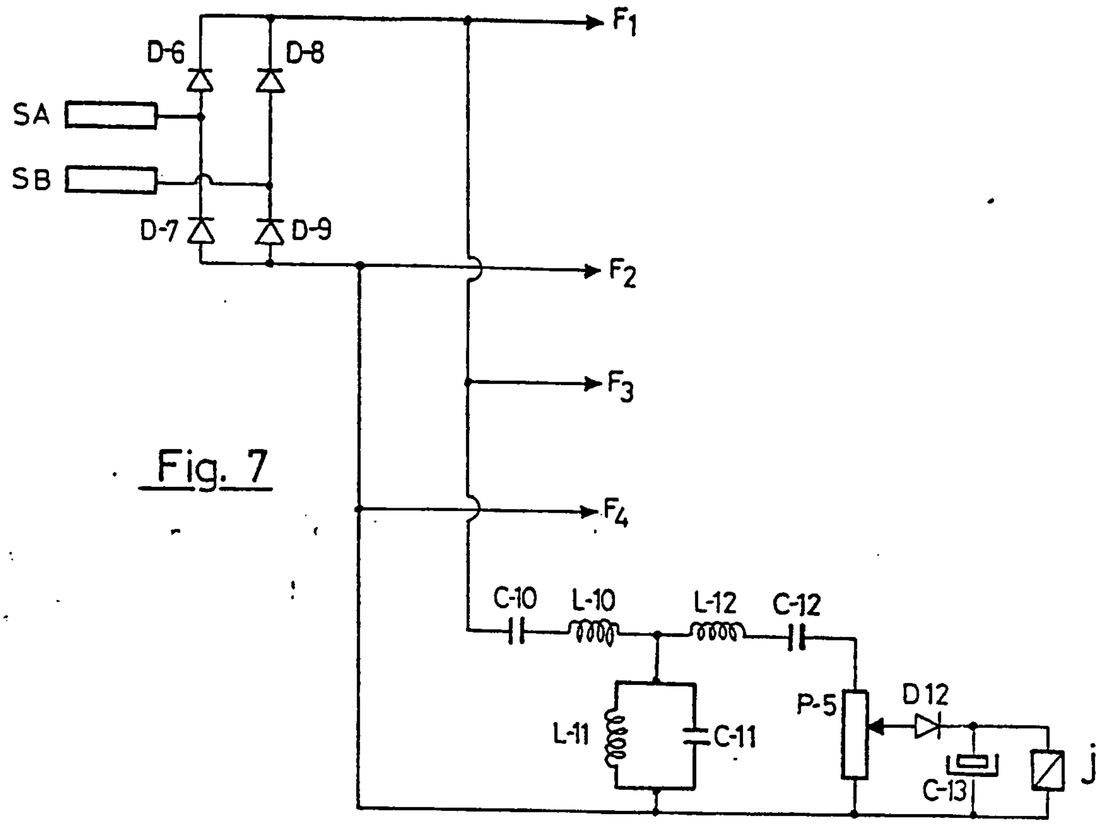
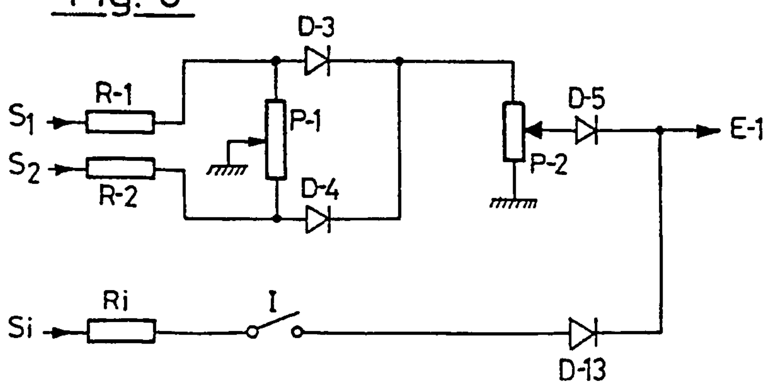


Fig. 7

Fig. 8



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EUROPEAN SEARCH REPORT

EP 81 30 3420.4

Category	DOCUMENTS CONSIDERED TO BE RELEVANT Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	FR - A - 1 559 339 (MINIMODELS LTD.) * abstract; pages 6, 7; page 2, right-hand column, lines 37 to 51; page 3, right-hand column, lines 13 to 23; page 4, right-hand column, lines 38 to 55 *	1-3, 13,14	A 63 H 18/12 A 63 H 18/16
Y	* abstract, parts A, B4°, B11°; page 4, right-hand column, lines 15 to 24 * & DE - A - 1 678 374 --	4-7, 10-12, 15	
Y	US - A - 3 841 556 (REYNOLDS et al.) * claim 1; column 1, lines 65 to 68; column 2, lines 1, 2; column 6, lines 33 to 46; column 7, lines 65 to 68; column 8, lines 1, 2, 9 to 27; column 9, lines 47 to 50; column 10, lines 29 to 40; fig. 1, 9, 16 * --	1-11, 13,14	TECHNICAL FIELDS SEARCHED (Int.Cl. 3) A 63 H 17/36 A 63 H 18/00 A 63 H 29/22
Y	DE - A1 - 2 941 024 (BROCKHAUS) * whole document * --	1-3,6, 15	
Y	US - A - 3 590 526 (DEYERL et al.) * claim 1; column 2, lines 9 to 14, 21 to 26 * --	3,13, 14	

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CATEGORY OF CITED DOCUMENTS
X: particularly relevant if taken alone
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A: technological background
O: non-written disclosure
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T: theory or principle underlying the invention
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L: document cited for other reasons
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X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	08-03-1982	CLOT

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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	US - A - 3 818 632 (TONG) * claim 4; column 1, lines 10 to 16; fig. 3 * --	8,9	
Y	DE - C - 800 829 (W. PREH) * claim 1; page 2, lines 81 to 86; page 3, lines 33 to 44 * ----	11,12, 15	
			TECHNICAL FIELDS SEARCHED (Int. Cl.³)